I’m Such a POTSy

Many people overlook the POTS line when thinking in modern communications terms. Think of it this way — you can access your house, computer, and devices from any cell phone almost anywhere in the world.

What do we need to know?

A=697 Hz
B=770 Hz
C=852 Hz
D=941 Hz
E=1209 Hz
F=1336 Hz
G=1477 Hz
H=1633 Hz

Table 1 – DTMF Frequencies

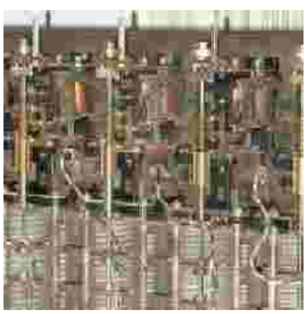

Fig. 1 – Early banks of electromechanical switches were the modern day technological wonder, as they decoded dialing pulse streams and routed connections without human operators.

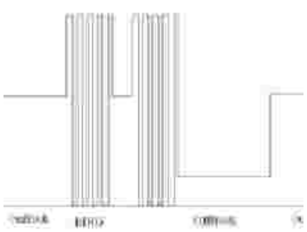

Fig. 2 – Simple voltage level signaling to ring and detect On-Hook and Off-Hook conditions.

POTS lines are two-wire connections that carry full duplex bidirectional analog signals through the public switched telephone network (PSTN). In the simplest terms, an analog telephone line is a 600 Ohm balanced line carrying two analog audio channels, one originating at each end point.

Note, switching networks is not just a term. The earliest electromechanical wonders were the automated switching stations that took pulse streams and routed a call without the need for operators plugging and unplugging cables. The Strowger Switch, patented in 1891, is a clever sequencing step multiplexer using banks of contacts, ratchets, and gears. (See Table 1) As pulses come in, it sequences the multiplexed line, and then steps to the next bank. Eventually, a source and destination address are y switched with dry contacts to make the connection through myriad possible connections.

It is interesting that, even today, PSTN lines still can use pulse dialing. In an emergency condition, you could connect to an operator by shorting the two telephone wires together briefly 10 times. Then, S.O.S. codes can be sent via shorting the lines in the Morse code patterns, even without a phone.

Modern POTS line connected systems use DTMF signaling to dial. Here, two of the eight distinct frequencies are combined into familiar touch tones. (See Fig. 1.) Each dialing digit, including star (*), pound (#), and four others, have associated tone pairs. In the next section, we will explore a DTMF decoder chip to give us the binary codes in digital 5 volt (V) signals.

POTS lines receive their power from the phone company. In fact, it was legislated that phone companies had to provide battery backups to ensure that telephones still work when the electricity goes out. Even cable modems that provide phone service are supposed to provide a six-hour battery backup capability.

Modern POTS connections use a modular RJ-11 jack and plug. While four wires are available (black, yellow, red, and green), typically only the red (ring) and green (tip) wires are used. Possible exceptions include a single, four-wire cable supporting two telephone lines or use of a black or yellow wire without rewiring if a green or red wire is broken.

When either no phone is connected or if the connected phone is On-Hook, the two phone wires typically sit at 48V provided by the telephone company (or equipment that is emulating the telephone company). An OnHook condition mostly means that the phone is an open circuit, but in reality, a high-impedance connection can actually listen to activity on seemingly ‘dead’ lines and be used to measure voltages.

When the phone rings, an 80V to 90V 20 Hz AC signal comes down the phone line into your phone or phone interface. (See Fig. 2.) The standard ring duty cycle is four seconds on and two seconds off. The higher voltage signal allows older phones to ring a bell. It also allows new equipment to detect the high voltage and signal a microcontroller that the phone is ringing. Our design will have a Ring Detect output.

Continue...

Telephone Interface II

When a phone receiver is taken Off-Hook, the voltage on the phone drops to 6V DC, and up to 26 ma can be drawn from the phone wires. The audio is AC both ways, coupled to the 6V DC level, and effectively rides on the DC bias. The 300 to 3.3 KHz bandwidth signals are pretty clean signals. Modems would ride their modulated data on this analog line and do pretty well.

The PSTN detects this voltage and current change and sends the familiar dial tone as an audio signal over the lines. Dial tone is the combination of l pulse or tone is detected, the dial tone disappears. Another familiar dual tone combination is the busy signal, which combines 480 Hz and 620 Hz.

Our design will also have an Off-Hook detector output. This feature can detect when someone local has engaged a local phone set. It also serves as verification when our design takes the phone set Off-Hook, either to answer or initiate a call.

To extract and send audio over the phone line, a 600:600 Ohm transformer is used. This option isolates our circuits from the telephone system wiring. As a matter of fact, all signals from our telephone interface are galvanomically isolated – the audio through a transformer and the Ring Detect and Off-Hook Detect signals through the use of opto-isolators.

We also use other protection mechanisms. Our design will include a metal oxide varistor (MOV) on the POTS side as a surge suppressor. Telephone lines can run long distances, and lighting strikes and other spikes can come in. We isolate and protect for this reason. We will also use Zener diode clamps on our side of the transformer to protect our circuitry from over-voltage spikes.

Technically speaking, any manufactured product that connects to a POTS line must comply with FCC Part 68 Title 47, which provides a standard for interfacing with the telephone network. With VoIP phones, cable modem phones, DSL phones, etc., these concerns are no longer valid since there is no POTS line returning to the supplier. If, however, you plan on making and selling a product that connects to the PSTN, you will need to go through FCC certification. You should be able to certify our design, since it complies and uses components that comply.

In the next part, our design will also use a 2-to-4 wire conversion technique that isolates received audio from audio we want to send out. Our transformer will be driven by an op-amp and will use an op-amp to extract audio. Our extracted audio can go to our DTMF decoder, an amplifier (e.g., a speaker phone), or any other section we wish to add. Once we have it extracted cleanly, it’s ours to use.

While our DTMF control will be one way (from outside in), we may want to be able to pass audio back out. For simple applications, we may want an acknowledge tone sent to us to verify a code was received and an action taken.

We also may want to make our link bidirectional by sending DTMF signals back. While this option is useful for machine-to-machine communications, it is not easy to decode DTMF signals unassisted. Instead, stay tuned. One of our future Gizmo Blocks will be a speech record/playback module that we can use to provide spoken prompts and acknowledge signals. We could also use it to customize an alarm system.

For example, we can have our speech module say, “Intruder alert – back door entry detected,” or anything else specific to our needs. The audio from our speech module can go right into our phone interface and be sent out.

The Block Diagram

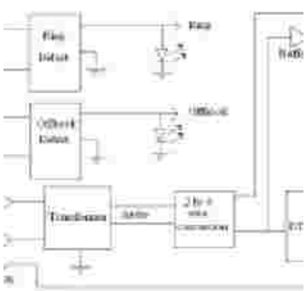

Fig. 3 – The top level block diagram indicates the major blocks we need to design and interconnect. In Part 2, we will explore the 2-to-4 wire conversion and implement the DTMF decoder.

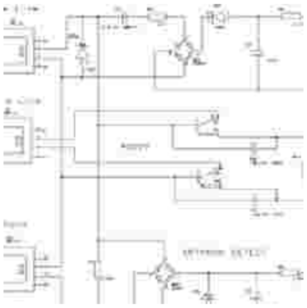

Fig. 4 – Our schematic for the Telephone Interface includes Ring and Off-hook detect as well as audio lines, protection circuitry, and a relay to take the phone line Off-hook at our command.

Proceeding from a top-down manner, generate a detailed block diagram. (See Fig. 3.) Our phone line comes in and is immediately protected by a 130V MOV. This system will kick in automatically if voltage becomes high enough to damage anything.

Note that a direct lighting strike will take out any suppressors we can use. Lighting damages equipment all the time. The MOV provides a little insurance, but be aware; it will do little if a large enough jolt hits it.

Our phone line also routes through a small series sense resistor to our equipment side RJ-11 jack, where a standard telephone will hook. We will test with a standard telephone and a remote telephone.

We detect Off-Hook and Ring signal levels and can use a relay to switch in a transformer that will allow us to take the phone Off-Hook. The transformer will pass audio to our DTMF decoder, either directly or through a 2-to-4 wire interface. This option permits 'transmit and receive,' as discussed earlier. We can also use LEDs as verification of status and debugging aids.

Our DTMF decoder will provide us a data-valid signal to alert our micro that DTMF signals are detected and are incoming. Our four data bits will be when the data-valid signal is active, allowing us to read the value and use it as part of our security code or to take action. We supply 5V and ground. We will use a single eight-pin 100 mil header for all of our signals to create an interface via a single cable.

The Schematic

Often, the parts you want are not available in the library of a schematic capture program. My first step was to create library elements for schematic and PCB symbols I wanted to use. With the missing symbols created, I could enter in a schematic. (See Fig. 4.)

Note that even though the telephone is a two-wire interface, RJ-11 jacks typically are four-wire, and the RJ-11 can actually hold six wires. We are not using four or six wires, but I decided to represent the RJ-11 as a six-pin connector. This setup leaves options for when we spin our PC board. (Only four pins are shown on the schematic symbol, but all six pins are on the PCB symbol).

One RJ-11 jack, J1, plugs into the actual phone line from the phone company, cable modem, etc. The telephone equipment then plugs into J3. This circuit board sits in between the phone line and equipment and acts as an interceptor.

I put a third jack, J2 in here. This jack can represent a switched line. During normal operations, telephones are connected normally. When we engage our board, we can disconnect the equipment from the lines to avoid interference. If we were making an alarm dialer, for example, this feature will not let any local phones stop the signal from getting out.

To detect Ring and Off-Hook conditions, we could use a level detector, but that option would require correcting the polarity regularly. Since modern telephone cables can either be strait or reversed polarity, the bridge rectifier approach lets this circuit work independently from the polarity.

So to detect Ring, I passed the 20 Hz through the bridge rectifier (BR1). Of the 80V, 56V are blocked by the Zener diode (ZD2) that charges the 10uF capacity (C2) and drives the opto-isolator (U1). The dual emitter H11AA1 is useful for the AC type of signal and will generate a pulse train on the output side.

The Off-Hook detector works in a similar way. The voltage that develops across the 120 Ohm sense resistor when the phone is taken off the hook is and drives another opto-isolator (U2). ZD3 protects against over voltage and the 1uF cap (C3) helps filter out false triggering noise.

Note that both opto-isolators are open-collector and need pull-up resistors. We use a standard 5V regulator (U3) from the 12V. Even though power is a e from the telephone lines, we use independent power to avoid electrical connection with the phone wires circuit. The opto-isolators do that for the line status, and the transformer does that for the audio signals.

We use a relay to switch in our transformer. Our relay (RL1) is double pole to allow both lines switch. I chose a 5V relay so that we can use the same regulated 5V that we generate on our board. We will also pass 5V along so that other boards may not need regulators and power connections.

The signal bleed capacitors (C6 and C7) allow a low-level signal to pass to our transformer even when the relay is not switched on. We can use this to listen to DTMF tones that other equipment is generating on the same phone lines. For example, if you are home, you can pick up any house telephone, enter your access and command codes, and it will still work if these capacitors are in place.

Since transformer types and characteristics can vary, I left a few placeholders for ‘fine tuning’ the audio. The transformer will typically have a low enough DC resistance (200 Ohms to 300 Ohms) to seize the line. When connected, the phone company assumes your phone is Off-Hook as long as the ‘load’ is present. If the resistance of the transformer is too high, then placing a parallel resistor at RA3 allows you to seize the line when connected.

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Telephone Interface III

I also left place holders for filter components RA1 and CA1. This setup allows adjustment of the transformer side impedance to limit frequencies and levels. As this function is not necessary in this application, I used jumpers for RA1 and CA1 and left RA3 unpopulated.

Table 2 – Bill of Materials from the Avnet Express Website.

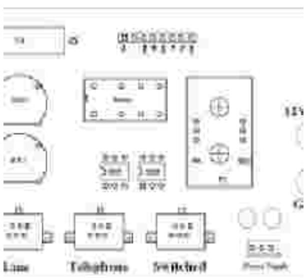

Fig. 5 –A little floor planning helps when prototyping, debugging, probing, testing, and hooking up.

Fig. 6 – Construction using perfboard is a little tougher to do, but in my opinion, it yields more rugged prototypes.

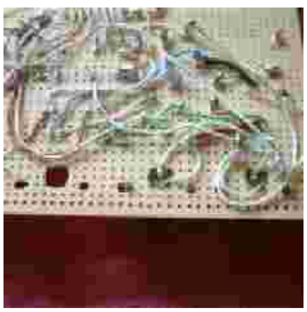

Fig. 7 – To mount the RJ-11 jacks, I pre-drilled for the mounting holes and where the wires solder in place. Since these parts are subject to stress, I also hot glued them in the other side.

Fig. 8 – The solderless breadboard allowed easy tests of the relay and the Ring and Off-Hook detection circuits.

Fig. 9 – With the intercepted phone line On-Hook, I was able to test the signal recovery through the bleed capacitors.

Fig. 10 – With the

intercepted phone Off-Hook, the Off-Hook Detect LED illuminates, and the audio is available for our DTMF detector.

The impedance on both input legs of the transformer should be the same to maintain a balanced line that wants the same impedance relative to earth ground. Any variation or imbalance could cause noise, typically 60 Hz hum.

Since the transformer I have is center tap, I ground referenced one side and passed both full tap and center tap out through my eight-pin interface connector (CNX1). This option provides more flexibility when interfacing to this board. For example, we can pass one output to a DTMF decoder audio stage (e.g., a speaker phone) and use the other tap to send voice or data out. It is a simple 2-to-4 wire interface.

Some Zeners (ZD4 and ZD5) protect the audio circuitry down the line. A spike squelching diode (D1) also helps protect the relay driving line from EMF back-spikes from the relay coil. An eight-pin 100 mil standoff header interfaces the complete phone interface from our next stage.

In Search of Parts

Using the Bill of Materials (BOM) tool online at the Avnet Express website, I was able to build a BOM for this project. (See Table 2.)

I chose to prototype the RJ-11 with a right angle through-hole part similar to the Corcom 6609214-5. These parts are pretty straightforward and a little more difficult to deal with than the discrete wire styles. I did not want dangling wires and connectors, so I decided to deal with the little extra work needed to use the through-hole soldered connectors.

I was able to find a 130V MOV similar to the Weidmuller 94015200 and use it as my surge suppressor. Once an MOV absorbs its rated energy, it acts as an open circuit. You may want to socket this part and replace it every so often if you live in a place that gets constant lighting storms.

I found the Panasonic ECW-F6135JL high-voltage capacitor to use for the coupling stage to the ring detector. The voltage does not have to be this high, but it does not hurt. This part is reasonably priced and will take the high-voltage ring signal with room to spare.

For the .047uF 150V signal bleed capacitors, I found a Panasonic CQ-B2473JF 250V polyester cap at 5%. The 10% could be used, but since they were the same price, I chose the 5%.

The bridge rectifiers are the popular through-hole button bridges. I chose the Zetex WO8G part. This part is a member of the family that ranges in voltages. For example, I could use the 400V WO4G, but I found that I can get the 800V parts for only $0.10 more. Again, the higher voltage rating is overkill, but it will not hurt.

I chose a generic 1N4758 for the 56V Zener diode — in this case, a Fairchild part. I also chose a 1N4744 as my 15V Zener — this time from Vishay. For a good general purpose opto-isolator, I chose an Everlight 4N25. These parts are six-pin though-hole and are easy to prototype with and replace if socketed. I decided to socket them because I never know how they will be mistreated, and I do not like to unsolder to replace a part.

I chose the Vishay H11AA1 for the Ring indicator opto-isolator. This part is specifically designed for isolated telephone applications and features a bidirectional emitter that engages the NPN transistor for positive and negative going waveforms at its input. Since the Off-Hook detector is a positive voltage that we control with the bridge rectifier, we do not need this functionality with its opto-isolator.

Note that I isolated both sides of the telephone line when not in use. Therefore, I chose a double-pole, double-throw (DPDT) relay. Again, a small (form C) through-hole part, such as the TE Connectivity 1-1462033-4, provides more than enough current capacity (2A per contact) and a 250V rating. In addition, the 5V contact fit nicely into our design.

I used a 600:600 Ohm transformer from parts I had lying around. The Vishay TA10EB07 series also will work for this project.

We do not need a center tap, but the transformer I found had it, so I decided to route it to the connector. This way, for our simple DTMF encoder, we do not need a 2-to-4 wire converter because we have two audio points.

Floor-Planning and Construction

It's nice to have good, clean documentation when debugging and trying to reproduce a design. A good floor plan is one of those tools that helps when building, testing, and maintaining a design.

I created a simple floor plan and laid out the main components. (See Fig. 5.) These components include the larger high-voltage cap, the relay, the phone jacks, the transformer, the bridge rectifiers, the opto-amplifiers, the power supply, and the signal header.

I used plain perfboard with holes at 100 mil spacings for this project. (See Fig. 6.) This option is a little tougher to do, but in my opinion, it yields a more rugged and durable board. I used banana jacks for the 12 Volt inputs.

From experience, I know that the RJ-11 jacks are subject to a lot of stress during use. To mount the RJ-11 jacks, I first precut and drilled the perfboard, snapped the jacks in (See Fig. 7), and hot glued the connector so that the stresses would not break the delicate soldering. I also used sockets for the opto-isolators.

The bridge rectifiers went right in, as did the Zeners, caps, and resistors. I had to drill for the transformer mounts and banana jacks. I placed the voltage regulator along one side and folded it over. Later on, if I draw more current, I can heatsink the regulator. I used a standard SIP 100 mil header for the signals and made a little cable that I can connect to a solderless breadboard for testing. (See Fig. 8.)

The solderless breadboard will make it easy to test the Ring and Off-Hook detector. Since the prototype board generates a regulated 5V, I placed a LED in series with a 1K resistor for both the Ring indicator and Off-Hook detect signals. The LED should light for each condition.

I also used the ground strip on the solderless breadboard to let me test the relay. By bringing the relay Pull signal to ground, I should be able to engage the relay and take the phone line into an Off-Hook condition.

The solderless breadboard also served as a ground point for the oscilloscope, so I will be able to observe the signaling, voice, and DTMF tones as audio waveforms on the scope.

When using a POTS line from the telephone company, use an isolation transformer for your oscilloscope. The oscilloscope may use earth ground as a reference and so does the phone company but at a different location. Differences in voltages can occur.

Powering Up for the First Time

I like to do things sequentially, so when it came time to power up, the first thing I did was to check the 5V regulator circuit. With 12V applied to the banana jacks, I measured a clean 5V everywhere except on the eight-pin interface header. A quick examination showed that I had forgotten to bridge the ground signal to the header. With a quick solder connection, power was clean and full everywhere.

With 5V on the prototype board, I tested the relay. Bringing the Pull signal to ground on the solderless breadboard let me hear the distinctive click of the relay engaging and disengaging. A pulse train on this signal would let it function as a rudimentary pulse dialer once the phone line was connected. So far, so good.

My next test would be the Off-Hook detect. I plugged in the phone line cable and an older style analog telephone to the telephone jack. With power on, I lifted the handset, but there was no LED.

After examining the schematic and board, I found I had the wrong resistor value for the opto-isolator LED driver. I had also placed the Zener in series instead of parallel. Both were limiting the current to the opto LED emitter. A quick update on the schematic and a swap on the board, and I was ready for a retest. This time, when I picked up the handset, the Off-Hook LED

illuminated and went out when I replaced the handset. To test the Ring Detect, I called into this phone line and watched as the Ring Detect LED flickered.

It was now time to test the audio. With the handset On-Hook, I picked up a parallel handset and punched in a DTMF digit. I could see the waveform for the DTMF codes on the scope as I dialed. (See Fig. 9.) This test verified that the signal bleed capacitors were passing the signal, even when the phone was On-Hook locally and the relay was not engaged.

Next I picked up the local handset and punched in some DTMF digits. The LED Off-Hook indicator lit, and I could see the waveforms on the scope. (See Fig. 10.) We now have our control signals, monitoring signals, and audio links in place. Next month, we will hang a DTMF decoder on this setup and make a home remote control interface that you can access with your cell phone.

Next Installment

Next month, we will design and build the 2-to-4 wire interface that will allow us to route extracted audio to several different stages, such as caller ID, speaker phone, and speech record/playback modules.

We will also set up the DTMF decoder to allow security code access and control.

While this project is not easy to build, it has a lot of potential for learning and use. Please let us know what you think about this project. If you like it, I will design a printed circuit board for easier construction, and we will make kit parts available in a bundle.

Enjoy, and have fun.

Remove 6 Supplier P/N: 4N25
Everlight Electronics
Optocoupler DC-IN
1-CH Transistor With
Base DC-OUT 6-Pin
PDIP Tube
Rail /
Tube
Min: 1 Mult: 1 1-$0.1281
500-$0.1244
1,000+-$0.1227
Americas
32,506 Stock
10 Week
Factory Lead Time
Remove 6 Supplier
P/N: ECW-F6135JL
Panasonic
Cap Film 1.3uF 630VDC
PP 5% 28 X 17.6 X
24.4mm RDL 25mm
Bulk
Bulk Min: 1 Mult: 1 1-$1.5700
2-$1.5100
25-$1.4300
50-$1.3500
100-$1.3100
200-$1.2700
250+-$1.2100
Americas
200 Stock
15 Week
Factory Lead Time
Remove 12 Supplier
P/N: ECQ-E2473JB
Panasonic
Bulk Min: 1 Mult: 1 1-$0.1210
2-$0.1160
25-$0.1100
Americas
1,740 Stock
Shopping Cart | **Contact Us**
Home Design Services My Account About Avnet
Order Status Shopping Cart Build a BOM Request for Quote Online Help Excess Inventory
Search Keyword or part number
Welcome: Jon Gabay
Logout | Change Password
Language: **English** Currency: **US Dollar (USD)**

Cap Film 0.047uF
250VDC PET 5% 7.9 X
4.5 X 7.4mm RDL 5mm
Bulk
50-$0.1040
100-$0.1010
200-$0.0970
250+-$0.0930
18 Week
Factory Lead Time
Remove 6 Supplier
P/N: 1-1462033-4
TE Connectivity /
P&B
Electromechanical
Relay DPDT 2A 5VDC
178Ohm Through Hole
Bulk Min: 1 Mult: 1 1-$1.7400
5,000-$1.7100
10,000-$1.6500
25,000+-$1.5800
Americas
469 Stock
16 Week
Factory Lead Time

Remove 12 Supplier P/N: W08G
Diodes, Inc / Zetex
Diode Rectifier Bridge
Single 800V 1.5A 4-Pin
Case WOG Bulk
Bulk Min: 1 Mult: 1 1-$0.4000
25-$0.3429
50-$0.3000
100-$0.2791
250-$0.2400
500-$0.2182
1,000+-$0.1846
Americas
735 Stock
9 Week
Factory Lead Time
Remove 18 Supplier
P/N: 6609214-5
Avnet P/N: RJ11-6X
TE Connectivity /
Corcom
Conn RJ-11 F 6 POS
2.54mm Solder RA
Thru-Hole 6 Terminal 1
Port
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433 Stock
12 Week
Factory Lead Time
Remove 6 Supplier
P/N: 9401520000
Weidmuller
DK 4/35 U 130V MOV
S14 -EA
Bulk Min: 1 Mult: 1 $10.0100 Americas
No Stock
4 Week
Factory Lead Time
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Fairchild
Semiconductor
Diode Zener Single 56V
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Bulk
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1,000+-$0.0227
Americas
9,840 Stock
12 Week
Factory Lead Time
Remove 6 Supplier
P/N: 1N4744A-TR
Avnet
P/N:
1N4744ATR/
BKN
Vishay / Siliconix
Diode Zener Single 15V
5% 1.3W 2-Pin DO-41
T/R
Cut Tape Min: 1 Mult: 1 1-$0.0664
26-$0.0553
50-$0.0474
100+-$0.0415
Americas
6,382 Stock
5 Week
Factory Lead Time
Remove 12 Supplier P/N: H11AA1
Vishay /
Semiconductor
Optocoupler AC-IN
1-CH Transistor With
Base DC-OUT 6-Pin
PDIP

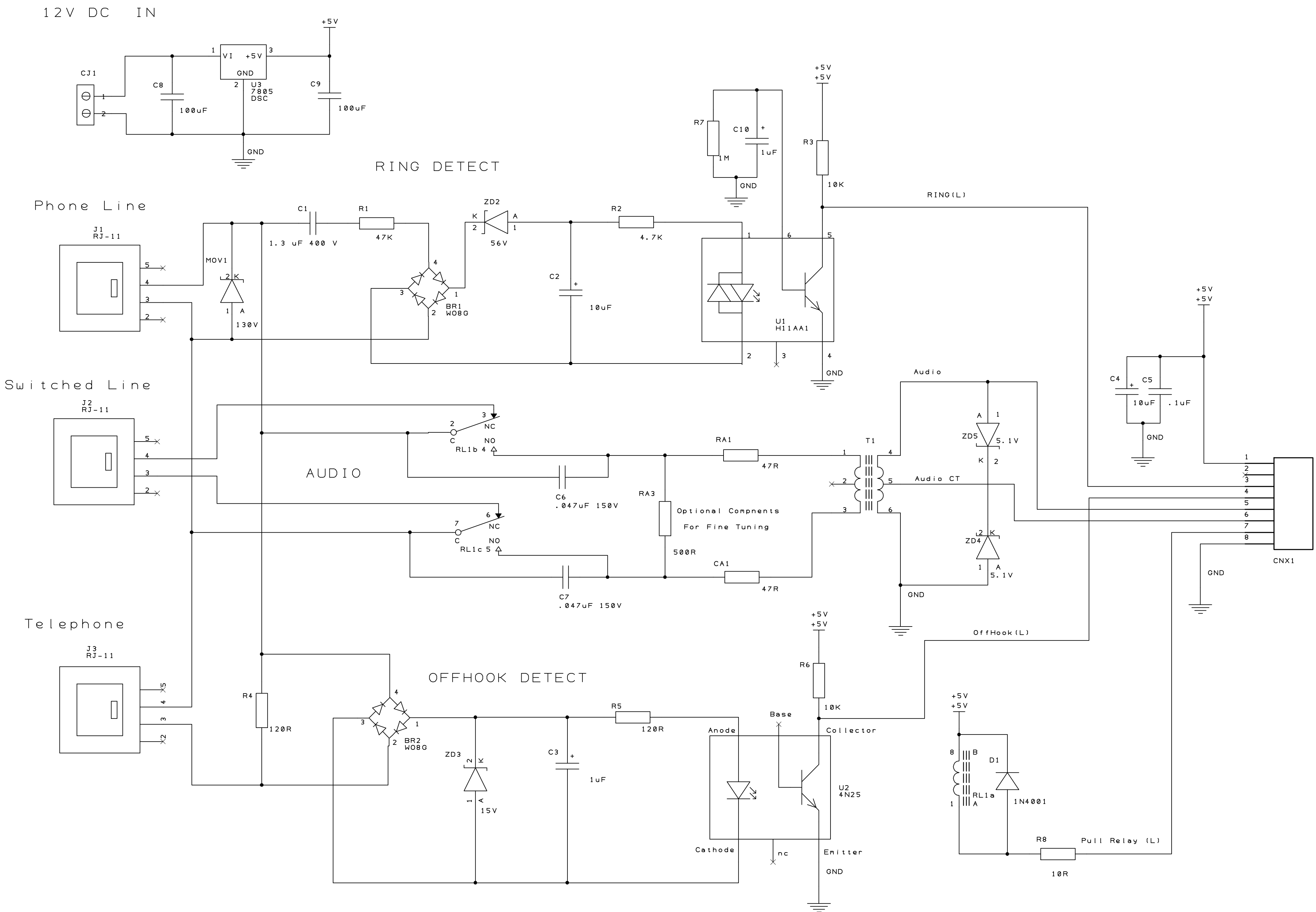
Bulk Min: 1 Mult: 1 1-$0.2983
500-$0.2887
1,000+-$0.2754
Americas
10,218 Stock
More Availability
Call for Delivery
Remove 12 Supplier P/N: 1N5231B
Fairchild
Semiconductor
Diode Zener Single
5.1V 5% 500mW 2-Pin
DO-35 Bulk
Bulk Min: 1 Mult: 1 1-$0.0123
100-$0.0114
1,000+-$0.0106
Americas
47,606 Stock
More Availability
12 Week
Factory Lead Time
Remove 12 Supplier
P/N: ECA-1EM101
Panasonic
Cap Aluminum 100uF
25VDC 20% 6.3 X
11.2mm RDL 2.5mm
180mA 2000 hr Bulk
Bulk Min: 1 Mult: 1 1-$0.0560
2-$0.0540
25-$0.0510
50-$0.0480
100-$0.0470
200-$0.0450
250+-$0.0430
Americas
17,698 Stock
More Availability
13 Week
Factory Lead Time

Global
View Stock in Europe
Remove 6 Supplier
P/N: LM7805ACT
Fairchild
Semiconductor
Standard Regulator Pos
5V 2.2A 3-Pin(3+Tab)
TO-220AB Rail
Rail /
Tube
Min: 1 Mult: 1 1-$0.2303
100-$0.2126
1,000+-$0.1974
Americas
4,145 Stock
More Availability
2 Week
Factory Lead Time
Remove 6 Supplier
P/N: ECA-1CM100
Panasonic
Cap Aluminum 10uF
16VDC 20% 5 X 11mm
RDL 2mm 30mA 2000
hr Bulk
Bulk Min: 1 Mult: 1 1-$0.0360
2-$0.0340
25-$0.0330
50-$0.0310
100-$0.0300
200-$0.0290
250+-$0.0280
Americas

2,275 Stock
13 Week
Factory Lead Time
Remove 6 Supplier
P/N: 1N4001
Avnet
P/N: 1N4001/BKN
Fairchild
Semiconductor
Diode 50V 1A 2-Pin
DO-41 T/R
Cut Tape Min: 1 Mult: 1 1-$0.0293
25-$0.0251
50-$0.0220
100-$0.0183
500-$0.0160
1,000-$0.0147
2,000+-$0.0140
Americas
4,965 Stock
13 Week
Factory Lead Time
Remove 6 Supplier
P/N: NCD104M50Z5UF
NIC Components
Cap Ceramic 0.1uF 50V
Z5U 20% Radial
6.35mm Bulk
Bulk Min: 1 Mult: 1 1-$0.0526
1,500-$0.0487
3,000+-$0.0454
Americas
400 Stock
12 Week

Factory Lead Time

Schematic
http://www.driveforinnovation.com/wp-content/uploads/2012/03/Fig_4_TP-1_sch.pdf



12V DC IN
CJ1
C8
100uF
U3
7805
DSC
VI
+5V
GND
C9
100uF
+5V
GND
RING DETECT
Phone Line
J1
RJ-11
MOV1
130V
C1
1.3 uF 400 V
R1
47K
BR1
WO8G
ZD2
56V
C2
10uF
R2
4.7K
R7
1M
C10
1uF
GND
R3
10K
+5V
U1
H11AA1
GND
RING(L)
Switched Line
J2
RJ-11
AUDIO
RL1b
RL1c
NC
NO
C6
.047uF 150V
C7
.047uF 150V
RA1
47R
RA3
500R
Optional Compnents
For Fine Tuning
CA1
47R
T1
Audio
Audio CT
ZD5
5.1V
ZD4
5.1V
GND
C4
10uF
C5
.1uF
GND
CNX1
GND
Telephone
J3
RJ-11
R4
120R
OFFHOOK DETECT
BR2
WO8G
ZD3
15V
C3
1uF
R5
120R
Anode
Cathode
Base
Collector
Emitter
nc
U2
4N25
R6
10K
+5V
GND
OffHook(L)
RL1a
D1
1N4001
R8
10R
Pull Relay (L)